RENEWABLE ENERGY FROM UTP WATER SUPPLY

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By

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Submitted to the Electrical & Electronics Engineering Programme
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CERTIFICATION OF APPROVAL

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July 2010

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Thian Hui Ching

ABSTRACT

In areas with high population such as hospital, universities, school, and housing area the water consumption is extremely high and UTP is facing the same problem. This high consumption of water has high potential to be use as an alternative of renewable energy source. The water flow inside the domestic pipeline to the users has kinetic energy to spin small scale generator turbine for electricity generation. The water is allowed to fall on the large turbine blades and the pressure will spin a shaft that is connected to a generator. Then the shaft of the turbine rotates in the electric generators where the current is produced. The faster the water flows and higher the head which is refer to the pressure of the water that strikes, the more electricity can be generated. Therefore, the aim of this project is to generate electricity through the conversion of one form of energy to another while the routine activities such as bathing, laundry and dish wash are done without extra charge on the water bill consumption. Feasibility study of UTP water system is conducted to obtain the data such as flow rate, water pressure and head of the location. The data obtained will be used to determine how much energy is actually converted and at the same time determine the size of generator needed. A prototype of the micro hydro generation system is been develop and it is tested to show the potential of consuming water distributed to universities, as an alternative of renewable energy source.

ACKNOWLEDGEMENTS

First and foremost, I am very grateful to God the Almighty for His mercy as He gave me the strength and ability to complete Final Year Project throughout the year of July 2009-July 2010.

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INTRODUCTION

1.1 Background of Study

Renewable energy is energy generated from natural resources [1] that are eco friendly, and a very efficient source of alternative energy which are renewable [2]. Renewable energy comes from the natural flow of sunlight, wind or water around the Earth. The renewable sector has been growing significantly since the last years of the 20^{th} century. In 2004; renewable energy supplied around 7% of the world's energy consumption and increases in 2006, whereby renewable energy supplied about 18% of the global energy consumption.

Hydropower is one of the largest renewable sources, providing 3% of global energy consumption and 15% of global electricity generation [3]. Hydroelectricity is the production of electrical power through the kinetic force produce from the flowing water. Flowing large quantities of waters have high potential energy from the river will flow towards the large turbines blades that will then start rotating. The shaft of the turbine rotates in the electric generators where electricity is generated. This electricity is the passed to the transformers from where it is connected to the main national grid. The faster the water flows and the more water, the more electricity can be generated.

Micro hydropower systems are relatively small power sources that I generally classify as having a generating capacity of less than 100KW which is enough to generate electricity to fulfill the basics needs such as lighting, electronics devices, small electrical appliances, space heating for of watering plants [9].

Types of hydropower are shown as below:

- **Pico-hydropower systems** has a maximum electrical output of 5KW.[10]
- **Micro-hydropower systems** are relatively small power sources that are appropriate for individual users or groups of users who are independent of the electricity supply grid, having a generating capacity of less than 100 kW.
- **Mini hydropower systems** have an installation capacity of between 100 kW and 1000 kW (1.0 MW).
- **Small hydropower systems** have a capacity of more than 1.0 MW and up to 10 MW. [11]

Micro hydro system consists of a water turbine that converts the energy of flowing or falling water into mechanical energy that drives a generator, which generated electrical power and is consider as the heart of a micro hydropower system, a control mechanism to provide stable electrical power, electrical transmission lines to deliver the power to the destination and battery charger to store energy.[12]

1.2 Problem Statement

The usage of water in UTP is enormous due to activities such as watering plants, drinking, bathing, cooking, sanitation and environmental usage such as artificial wetlands in UTP. In such a high usage of water in UTP, thus UTP is currently paying an average RM142, 171 .63 which is equivalent to 113, 2490.32 gallons of water per year. Figure 1 shows the amount paid by UTP for water in four years. This large amount of water can be fully utilized to produce renewable energy through simple conversion of one form of energy to another renewable energy. The micro hydro energy which is implemented will be proposed to be install at the domestic pipelines whereby the water flow inside the pipelines has potential to convert the kinetic energy from the water to electrical energy. The consuming water distributed to users for routine activities can also be used to generate electrical energy.

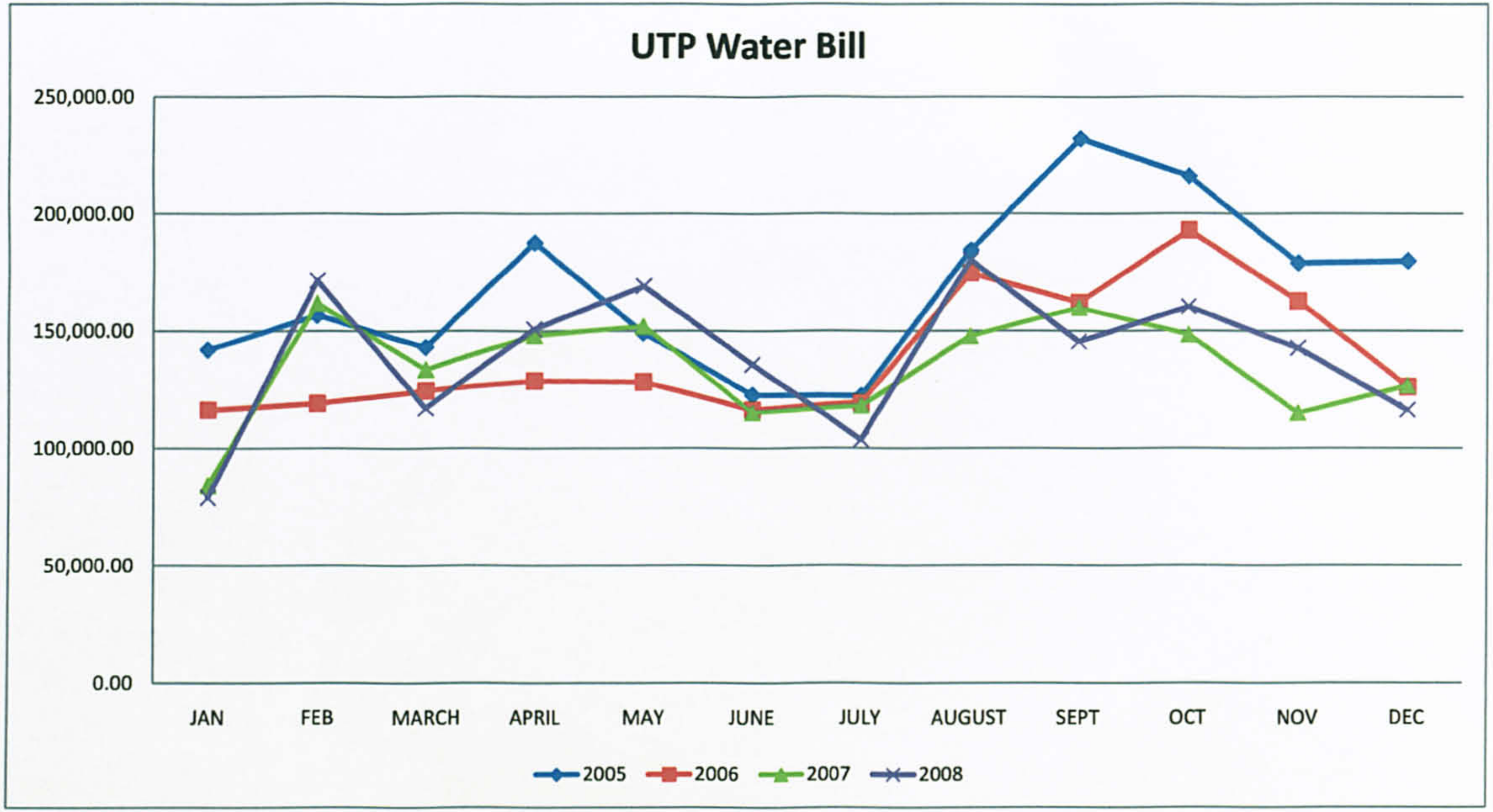


Figure 1: UTP Water Bill (RM)

1.3 Objectives and Scope of Study

The main objective of this project is to:

i. To develop a scale down model of micro hydro generation system
ii. To conduct feasibility study in UTP water supply
iii. To design micro hydro generation system to generate renewable energy
iv. To perform an experiment on the prototype that has been developed.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Developing a micro-hydro system is basically based on the concept use in dam system. The production of electricity from hydropower has been the first renewable source used to generate electricity in European [12]. According to the previous researches micro hydro power was once the world's well-known source of mechanical power for manufacturing. Water power predates the use of electricity and it was primarily used to grind grain where water had a vertical drop of more than a few feet and sufficient flow [12].

A typical hydropower system consists of dam, reservoir, penstocks (pipes), a powerhouse and an electrical power substation. The dam wills stores water and create the head, penstocks will carry water from the reservoir to turbines inside the powerhouse, the water will then rotates the turbines which drive generator that produce electricity [13] as shows in Figure 2:

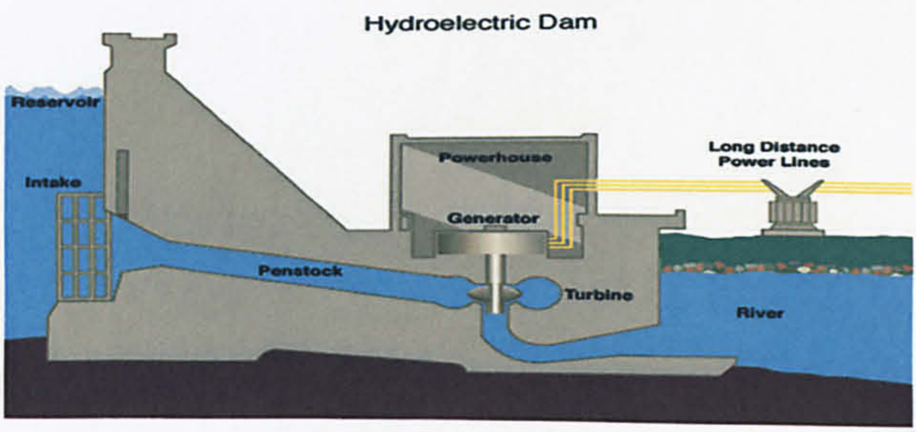


Figure 2: Hydroelectric Dam [13]

There are few types of hydropower systems in this world which are the conventional type and pumped storage type. Conventional hydropower system uses one-way water flow to generate electricity which divides into two categories which are run-of-river [14] in Figure 3 and storage plants [15] in Figure 4:

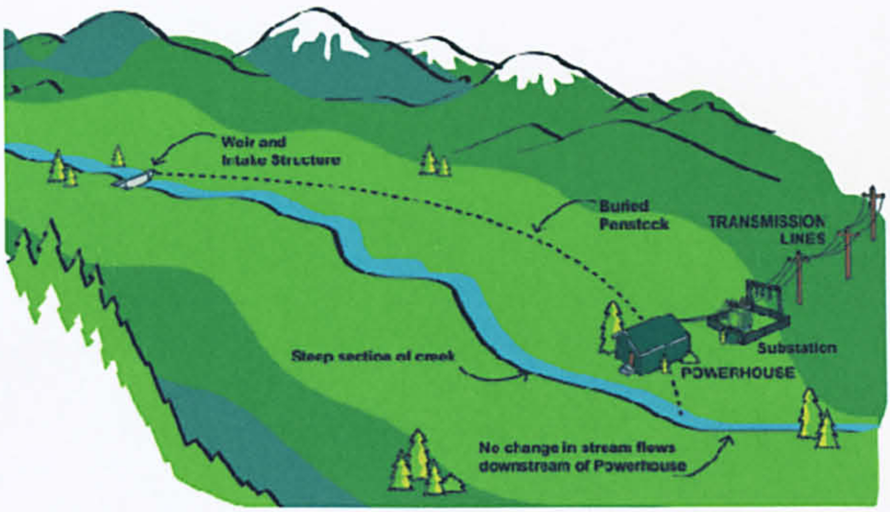


Figure 3: Run-of-river [14]

Run of river classified as a type of hydro generation whereby natural flow and elevation drop of a river is utilized to generate electricity. The water flow naturally through the large reservoir produces consistent and steady.

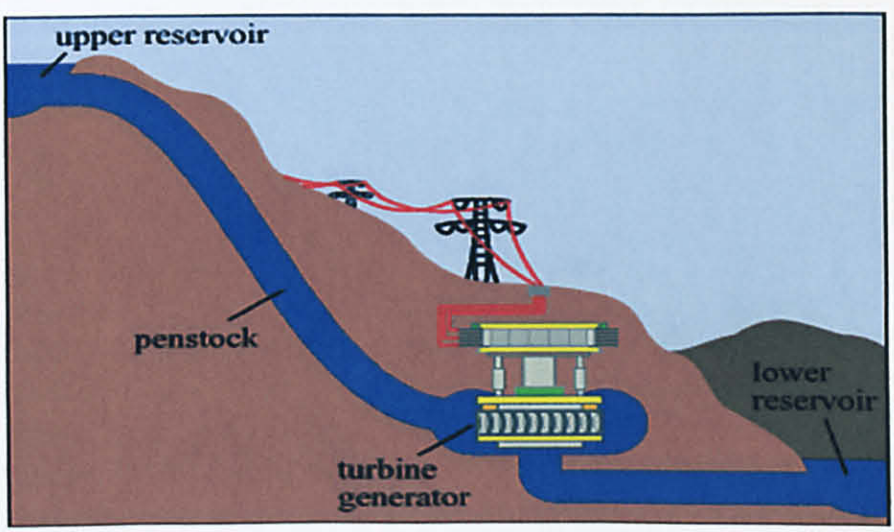


Figure 4 : Storage Plants [15]

Storage plant store the water on the upper part of the reservoir as shown in Figure 4.

The water will then flow through the turbine generator, exits and is then carried down to the stream. This type of hydropower system applied a one –way water flow to the plant.

In contrast to conventional system, pumped storage systems reuse water. The water will flows from the turbine into a lower reservoir which situated below the dam after the water produces electricity. During the periods of low energy demand, the water will be pumped into an upper reservoir and reused during the periods of peak demand [13].Figure 5 shows the model of pumped storage system:

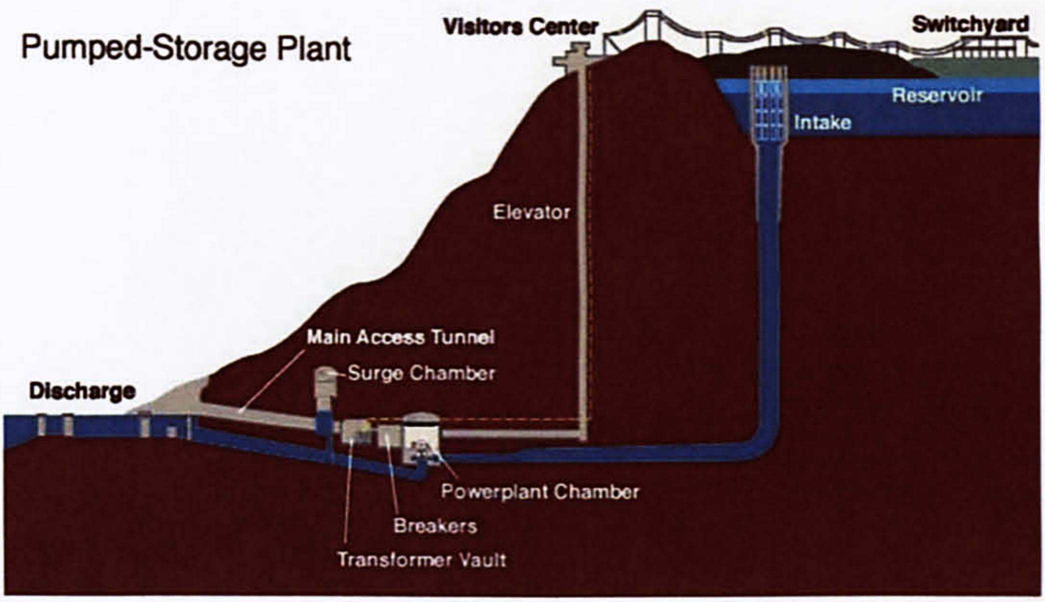


Figure 5 : Pumped Storage System [13]

2.2 Head and Flow Rate

Hydropower is based in simple concepts where it converts the energy flowing water into electricity. The quantity of electricity generated is determined by the volume of water flow and the amount "head" which is referring to the height between water intake and the turbine [4].

Head is water pressure created by the vertical distance between the intake and turbine. The vertical drop creates pressure at the bottom end of the pipeline where the pressurized water emerging from the end of the pipe creates the forces to drives the turbine.

Net head is the pressure available at the turbine when water is flowing ,which will always be less than the pressure when the water is turned off(static head).The pressure is lower than the pressure during static head is due to the friction between the water and the pipe[5].

There are many methods of head measurement [7]. However, since the proposed micro hydro generation system uses consuming water distributed to houses whereby the utility's water tank can be very far from houses, thus the simplest and most practical method for head measurement is water-filled tube and calibrated pressure gauge. The water pressure obtained representing the net head of the system. It will use to calculate the actual power available from the water supply. Through this method, the reading obtained from pressure gauge which is in psi will be converted to head in meters by applying this equation below:

$H= (0.704)\ (P)$

where,

$P=$ *Pressure (psi)*

$H=$ *Head (meter)*

On the other hand, water flow is the water quantity /volume which passes through a given surface per unit time and represented by the symbol Q, flow rate [6]

$Q= A.V\ [m^3s^{-1}]$

where,

$A=$*Area*

$V=$*Velocity*

Amount of electricity that can be generated is determined by the flow rate of the water. The amount of power produce will be proportional to the rate of flow where higher flow rate will produce high level of kinetic energy which will turn the runner blades of a turbine and start rotating. This turbine runner is usually directly coupled to the generator shaft. The shaft of the turbine rotates in unison with a series of magnets inside the generator .The large magnets rotate past copper coils, which will produce alternation current. This electricity is the passed to the transformer from where it is connected to the main national grid.

2.3 Power conversion and Efficiency

The electricity is generated from the conversion of one form energy to another. The turbine converts the energy in the moving water into rotational energy as its shaft, which is then converted to electrical energy by generator [5].

The two types of energy involved are kinetic energy and potential energy. Kinetic energy is the energy that an object has because of its motion relative to its surrounding. It has the ability to do work on other object by applying a force to those objects in order to change its velocity [7]. Another types of energy involve is potential energy where potential energy is the energy that is stored in a system by virtue of forces between some distance of objects.

When the object (in this case is the flowing water) move under the influence of the force between the potential energy, then work is done as the force displaces of the objects from their initial positions and thus energy is transferred. The potential energy of a volume of water that falls through of a height is obtained as below [8]:

$$
\begin{aligned}
F_{gravity} &= (mass)(acceleration\ due\ to\ gravity\ near\ Earth) \\
&= (mass)(9.80\ m/sec^2) \\
P.E &= (F_{gravity})(H) \\
&= (mass)(9.80\ m/sec^2)(H)
\end{aligned}
$$

In a micro hydro system, the mass of the water that is falling is determined by how much volume it occupies where:

$Mass = (Density)(Volume)$

where,

$density = 1gm/cm^3$ *(for fresh water)*

Thus, potential energy of a volume of water is :

$P.E = (98000J/m^4)(VH)$

where,

J is the symbol for the unit of energy called the joule.

Amount of power available from the micro hydro system is also directly related to the flow rate, head and the force of gravity.

The electrical power can be calculated using the equation below:

$P_{theory} = (Q)(H)(g)$

where,

P_{theory} = *theoretical power output in kW*

Q = *Usable flow rate* m^3/s

H = *Gross head in m*

G = *Gravitational constant (9.8m/s)*

During the conversion of one form of energy to another form of energy, some of the energy will be lost through friction at every point of conversion .Efficiency is measurement of how much the energy is actually converted. It is represented as below [9]:

Efficiency = (electrical energy output) / (potential energy)

= (electrical energy output) / $([98000J/m^4] \times VH)$ [8]

Net energy =(Gross energy)(Efficiency) [9]

2.4 Pipeline System

One of the important parts of a micro hydro system is the pipeline where it moves/supplies the water to the turbine. The pipeline is also the enclosure which creates head pressure as the vertical drop increases. Pipeline diameter, material and routing all affect the efficiency of the conversion of energy. Small diameter of pipeline is able to reduce the available horsepower significantly while larger diameter have less friction as the water can easily travels through [6].

The proposed micro hydro system will use the water source from consuming water distributed to consumers. Thus, the system must be designed with the ability to produce high water pressure so the turbine will be able to rotate at the most possible speed. At the same time the water is fully utilized and can be also used in the daily routine activities such as bathe, laundry and other activities.

2.5 Turbines and Generators

Main components or the 'heart' of the micro hydro system are the turbine where it converts power to rotational forces to drive the generator .For maximum efficiency, the design of the turbines would match the calculated head and flow. Two basic kinds of turbines are considered which are impulse turbine and reaction turbines.

Impulse turbines converts the water under pressure to a fast –moving jet using a nozzle which is located at the end of the pipeline .The fast moving jet is then directed at the turbine wheel which is also called a runner. This runner is designed to convert as much of the jet's kinetic energy as possible into shaft power. The common impulse turbines are cross-flow, pelton and turgo [14].Figure 6 shows the turbine application chart for selection process.

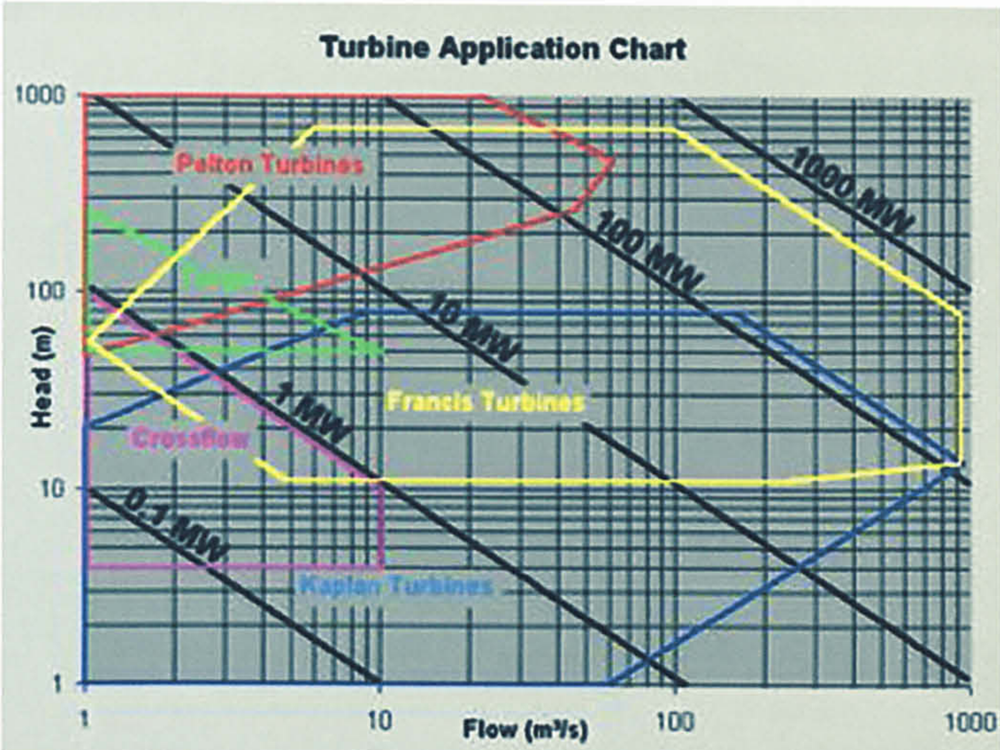


Figure 6: Turbine Application Chart

On the other hand, reaction turbine converts the energy of the water to pressure then to velocity within the guide vanes and turbine wheel itself. In this situation, a turbine such as reaction turbines that operate fully immersed in the water and are typically used in low to moderate head systems with high flow is needed. The turbine system is designed around the net head and design flow in order to increase the efficiency and reliability [14].

Generators in micro hydro system are used to convert the rotational energy form the turbine shaft into electricity. The selection of generators for the micro hydro system is depending on the type of usage on as follows:

i. Types of supply system and electrical load:

   There are two types of generators which can be choose from which are Direct Current(DC) generator and Alternating Current(AC) generator.

DC generator or alternators with rectifier are typically used with small household systems and normally amplified with batteries for reserve capacity. Besides, the batteries are also use by inverters for converting electricity into the AC which is required by most appliances [8].

AC generator are typically used in the system which produce 3KW or more and it is easily changed by transformer, The efficiency can be improved with long transmission lines. Frequency is one of the critical aspects in an AC generator that is determined by the rotational speed of the generator shaft; faster rotation generated a higher frequency. In battery –based hydro system, the inverter produces an AC waveform at a fixed frequency. In non-battery hydro system, the turbine controller regulates the frequency [8].

ii. The estimated power of a micro hydro generation system

In order to estimate power of s micro hydro generation system, the amount of power available from the water flow inside the domestic pipelines must be determined. This depends on the water pressure of water available and friction losses in the pipelines.[8]

iii. Available generating capacity in the market

iv. Generator with cost effective

2.6 Battery Charger Circuit

Battery charger is used to stored energy into a rechargeable battery .The rechargeable battery that is proposed in this project a 6V sealed rechargeable battery. Main part of the circuit is LM317 which is known as the "three terminal adjustable regulators".

LM317 can support input voltage from the range 3V-40V and the output voltage from range of 1.25V-37V and with the current rating of 1.5A. Current limiter is built in this part whereby to prevent output current from exceeding the rated current and it will automatically reduce its output current if an overheat condition occurs under load. Variable resistor in the circuit is used to vary the resistance in the circuit. This is to control and maintain the current to 1.2A and above.

2.7 Converter Circuit

This circuit consists of rectifier circuit, filter circuit and a regulator circuit. High voltage that is generated is converted to smaller voltage through a transformer. Then this small voltage of alternating current(AC) will be converted to direct current(DC)through the rectifier circuit which consists diodes .In order to provide a smooth DC voltage ,a capacitor filter is installed in the converter circuit. This capacitor filter will filter out the dc components while attenuating as much AC component as possible. Output from the rectification circuit is connected to the regulator circuit. This voltage regulator circuit will maintain a constant voltage level according to the desired voltage.

The block diagram combining the three types of circuits is as shown in Figure 7:

Figure 7: Block Diagram for the Circuit

As for the converter circuit, the AC voltage which is fed to the circuit is converted to DC voltage through the rectifier circuit. Figure 8 shows the input and output of rectifier circuit [16]:

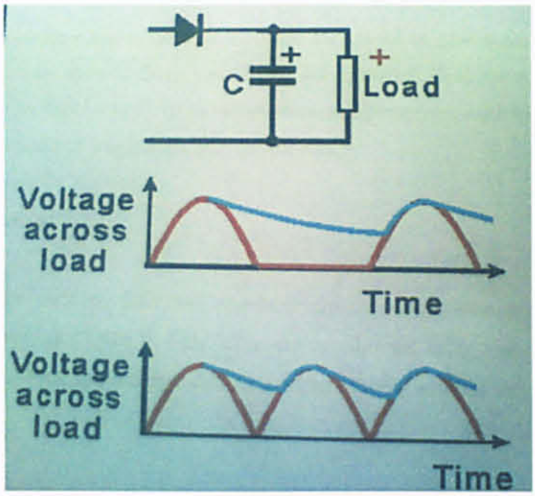


Figure 8: Input and Output of rectifier circuit [16]

On the other hand, filter circuit is used to reduce ripple of the signal. To eliminate ripple action in the signal, the RC charging time of the filter capacitor must be short while RD discharge time must be long. In short, the capacitor must charge up as fast as possible and no discharge during the charging season, Figure 9 shows the effect of the filter capacitor [17]:

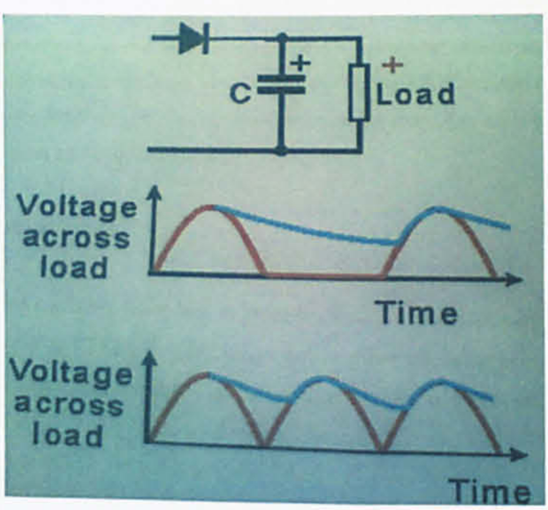


Figure 9: Output of the capacitor filter [17]

2.8 Switching Circuit

The switching circuit is important as an automatic switch for a generated voltage supply. The rechargeable circuit will act as a switch to exchange from generated voltage to the power supply when the rechargeable battery is fail. On the other hand, the switching circuit will switch back from the backup power supply to generated voltage if the battery is fully charged. Figure 10 shows the switching circuit:

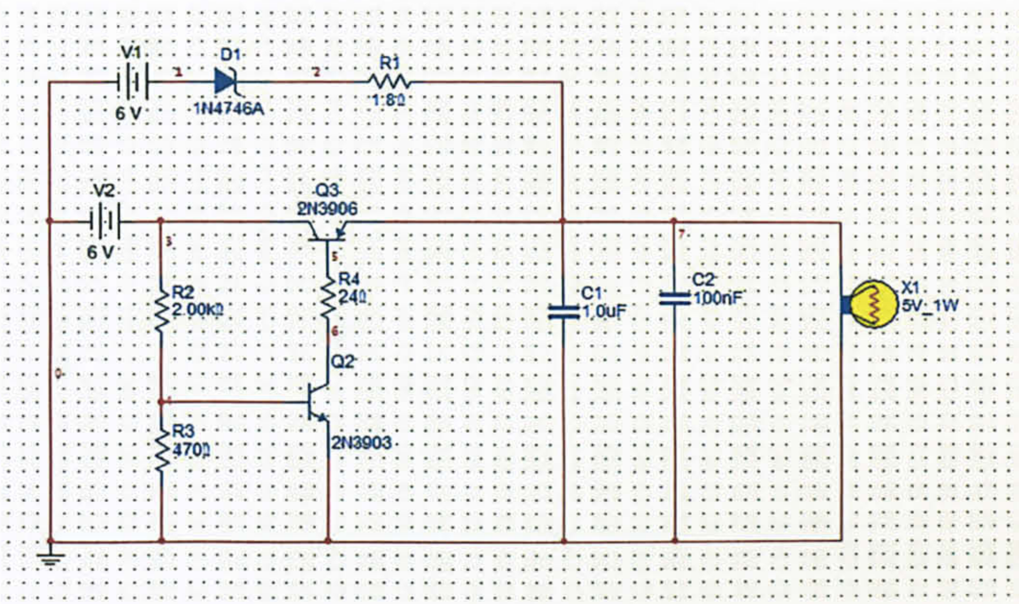


Figure 10: Switching Circuit

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

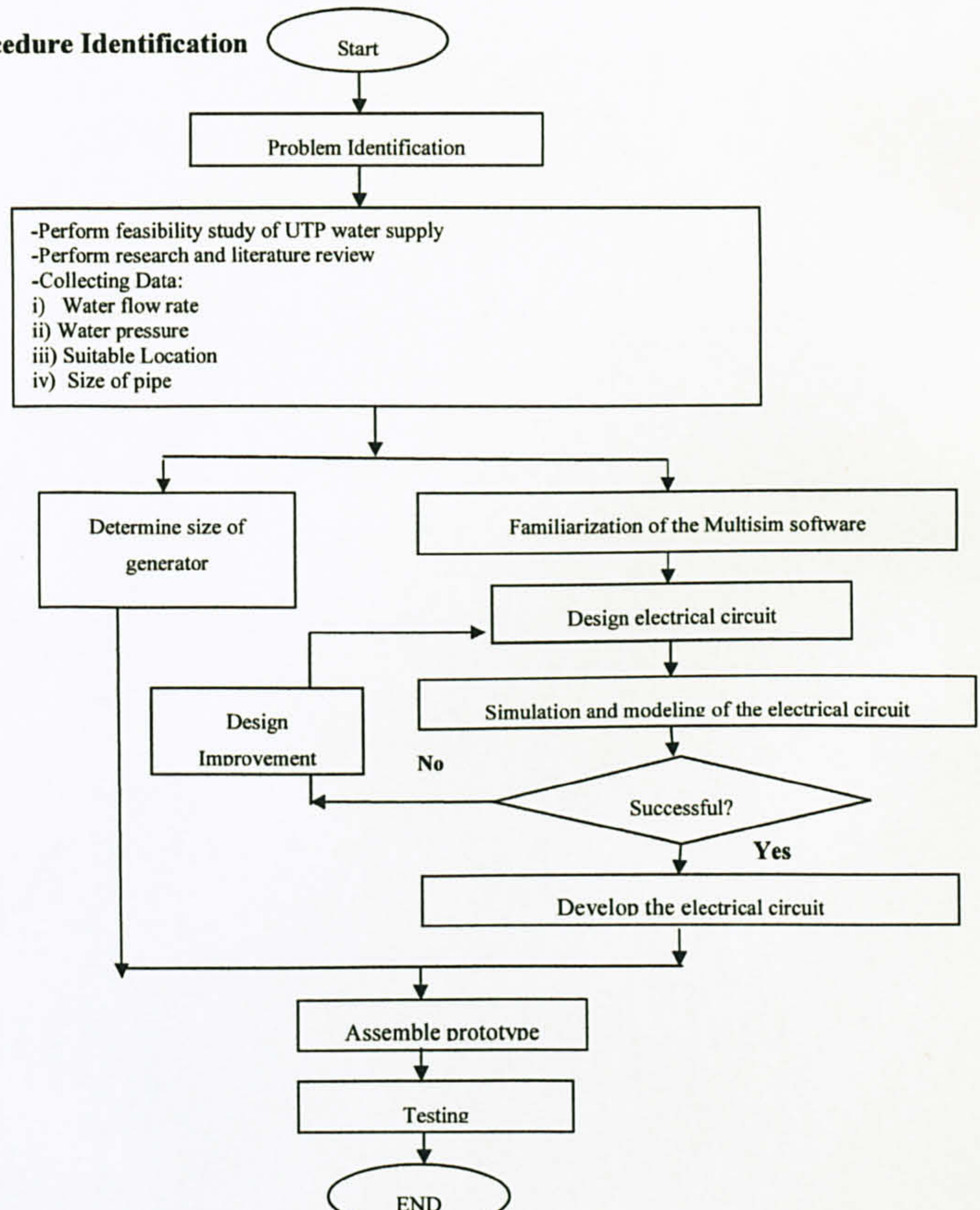


Figure 11 : Flow Chart of Project

3.2 Research Activities

3.2.1 Semester 1

Data Gathering on UTP Water Bill

All the data of UTP water bill from 2005-2008 is gathered through UTP Maintenance Department, The data of UTP water bill (refer to Appendix 1) for every month from 2005- 2008 and the average of amount paid for the 4 years is been study. Feasibility study is done and the graph of the analysis is plotted out for future research (Refer to Figure 1).From the data obtained, the volume of water (in liters) used in every month can be calculated as shown in Figure 12.

Plan Overview and Site Visit

The plan overview of the UTP water piping system is been analyzed and all the information regarding the diameter and length of the pipe is gathered. A site visit is been conducted and few locations with high pressure are considered. The pictures of the site visit are attached in Appendix 2.The flow rate and water pressure of the selected point is gathered.

Research of Battery Circuit

Research of the battery circuit in been done and few types of circuit is gather. The circuit will be constructed in Pspice and will be test run for the optimum output.

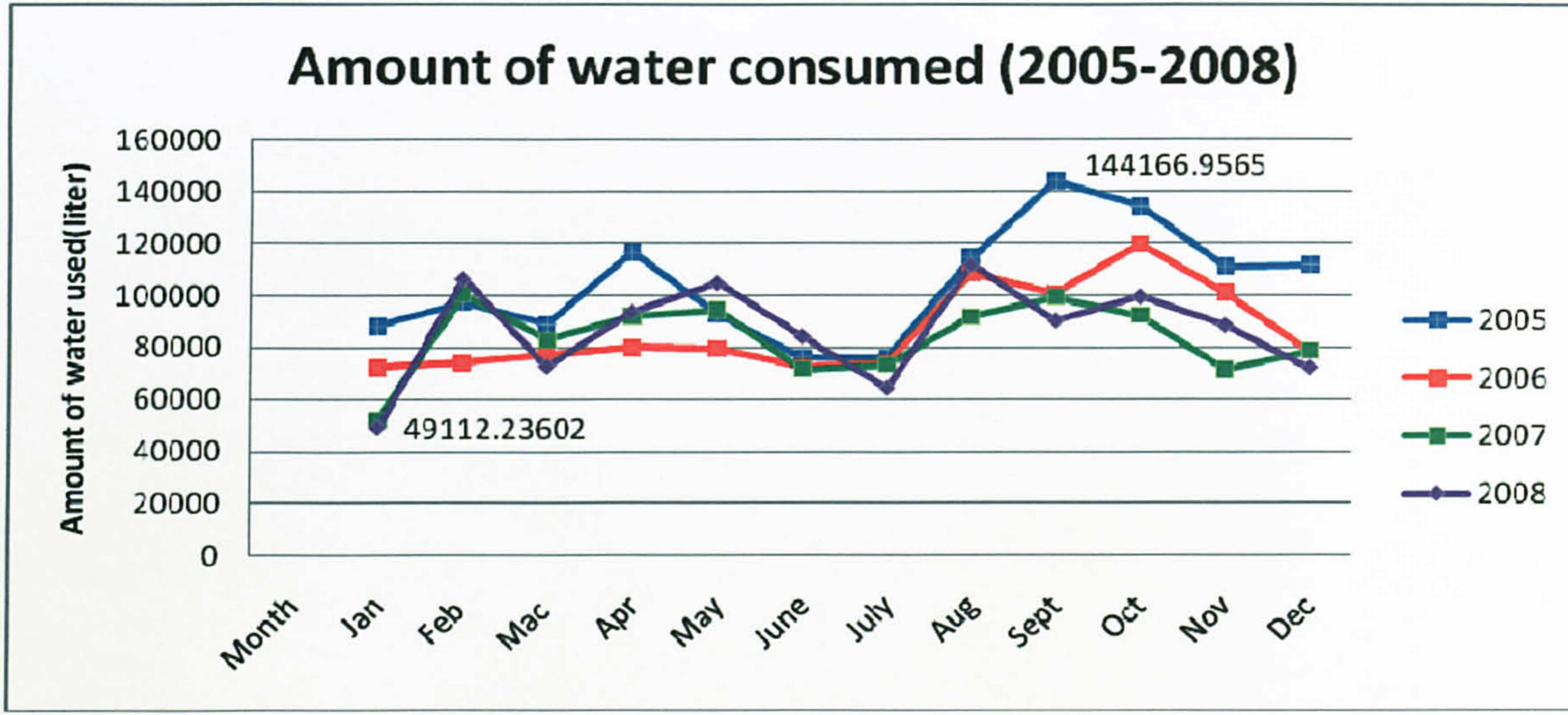


Figure 12: Amount of water consumed (2005-2008)

3.2.2 Semester 2

On Site Testing

On site testing is done at the secondary reservoir tank (old USM Building).A flow meter is borrowed from Civil Department and it is used to determine the flow rate of the water on site. During the testing, the valve of the tank is open and a flow meter is place in front of the opening of the tank. The water is left to flow and the reading of flow rate on the meter will be taken when it give a constant value. This test is done three times to obtained an average reading of the flow rate and to make sure it is precise as well as consistent.

Planning of design concept

The design planning of the electrical component of the micro hydro system is been plan as Figure 13:

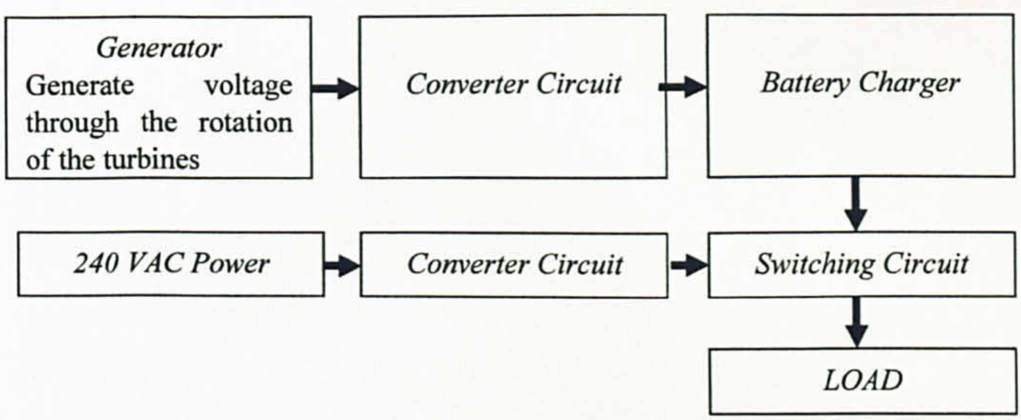


Figure 13: Block diagram of a hydro generation system

Load will be support by two main supplies which are direct supply from 240VAC power supply and from the generator of the micro-hydro system.

In case of any failure or interruption in the electrical network from generator which supplying the load, there is always a back up supply directly from the 240VAC power supply and vice versa.

Construction of Electrical Circuits

Mainly are three types of circuit that are needed to be construct and validate. The circuits are switching circuit, Converter Circuit and Battery Charger Circuit. The simulation in Multisim is done to get the expected output from the circuit.

Installation of new motor

A new motor is installed in the system and it is couple to the turbine. The specification of the motor chosen is as follow:

Table 1: Specification of the motor

Specification: width	39mm
Length	67 mm
Shaft diameter	4 mm
Shaft length	8.55mm
Voltage rating	12Vdc
Power Rating	2.2W
Output ratio	9:1
Output Speed	330 rpm
Torque (Nm)	0.12

3.3 Tools and Requirement

i. Software : Multisim and Pspice
ii. Hardware : Mini generator, AC/DC converter, battery charger circuit and rechargeable battery.

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Data Gathering

4.1.1 Result of Estimated Output at 5 Testing Point

Testing is conducted by UTP students and lecturer collaborating with Lembaga Air Perak personnel on 31st March 2010 at 5 main points which are:

Table 2: Testing Point

Location	Picture
i. UTP Main Intake	
i. Reservoir Tank(Incoming) ii. Reservoir Tank (Outgoing)	

iii. V4 Pipeline	
iv. USM Reservoir Tank	

Table 3 shows the data obtained from the different testing point:

Table 3: Site visit test

	UTP Main Intake	Reservoir Tank (Incoming)	Reservoir Tank (Outgoing)	V4 Pipeline	USM Reservoir Tank
Average Flow rate (m^3/s)	239.94	303.38	235.02	75.2	94.30
Estimated Output power(W)	2966	212100	164300	959.5	2775.25

Calculation on the estimated power produced in each location is based on the formula below:

$P_{theory} = (Q)(H)(g)$

where ,

Q= *Usage flow rate* (m^3/s)

H=*Gross head (meter*

G=*gravitational constant (9.81m/s)*

4.2 Simulation Circuit

There is three circuits involved:

i. Switching circuit

ii. Converter circuit (rectifier, capacitor filter, voltage regulator)

iii. Battery charger circuit

All of the circuits have been simulated using Multisim.

4.2.1 Switching circuit

Switching circuit is use as a switch for the micro hydro system. The whole system is supported by two types of power supply which are 240 AC power supply and power supply generated from the micro hydro turbine. If there is a power breakdown occurs at the the switching circuit will act as a switch to switch from the generated hydro energy to the main supply and vice versa. The voltage generated from the generator is represent by V2 will deliver voltage of 5.26V to the load. If the voltage from V2 is not sufficient and the battery has used up, the voltage from power supply V1 will provide the voltage to the load automatically. Thus it is observed that during V2 is 0V, V1 will supply to the voltage 5.01V to the output. The result obtained from during the breakdown is shown in Table 4:

Table 4: Results obtained from switching circuit testing

Power Supply V_1	Power Supply V_2	Output
6V	0V	5.01V
0V	6V	5.26V
6V	6V	5.35V

The switching circuit mechanism is based on the application of transistor is shown in Figure 14:

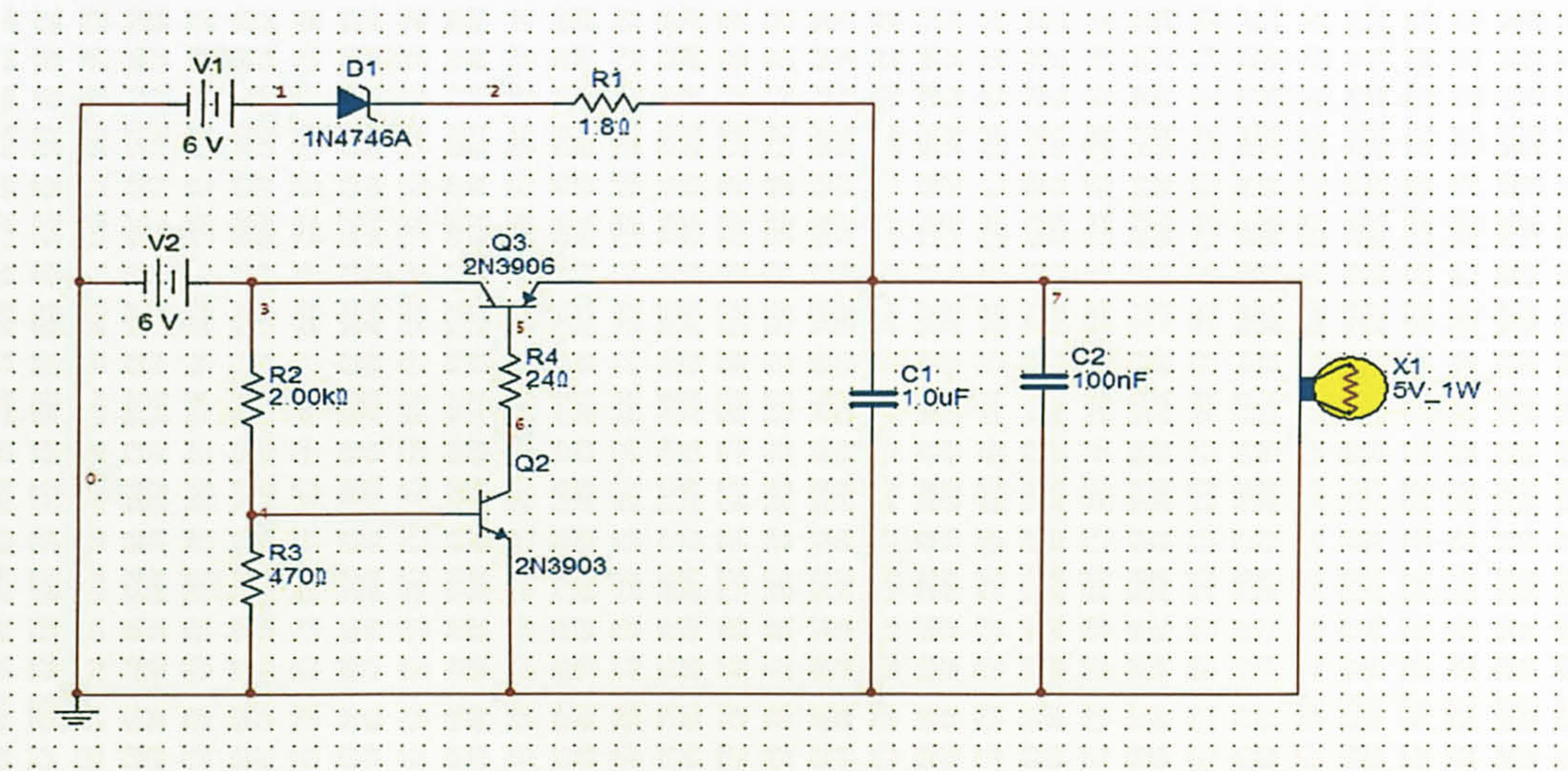


Figure 14: Switching circuit

Figure 15 shows the diagram of the switching circuit during the breakdown operation:

<u>During V_2 Breakdown :</u>

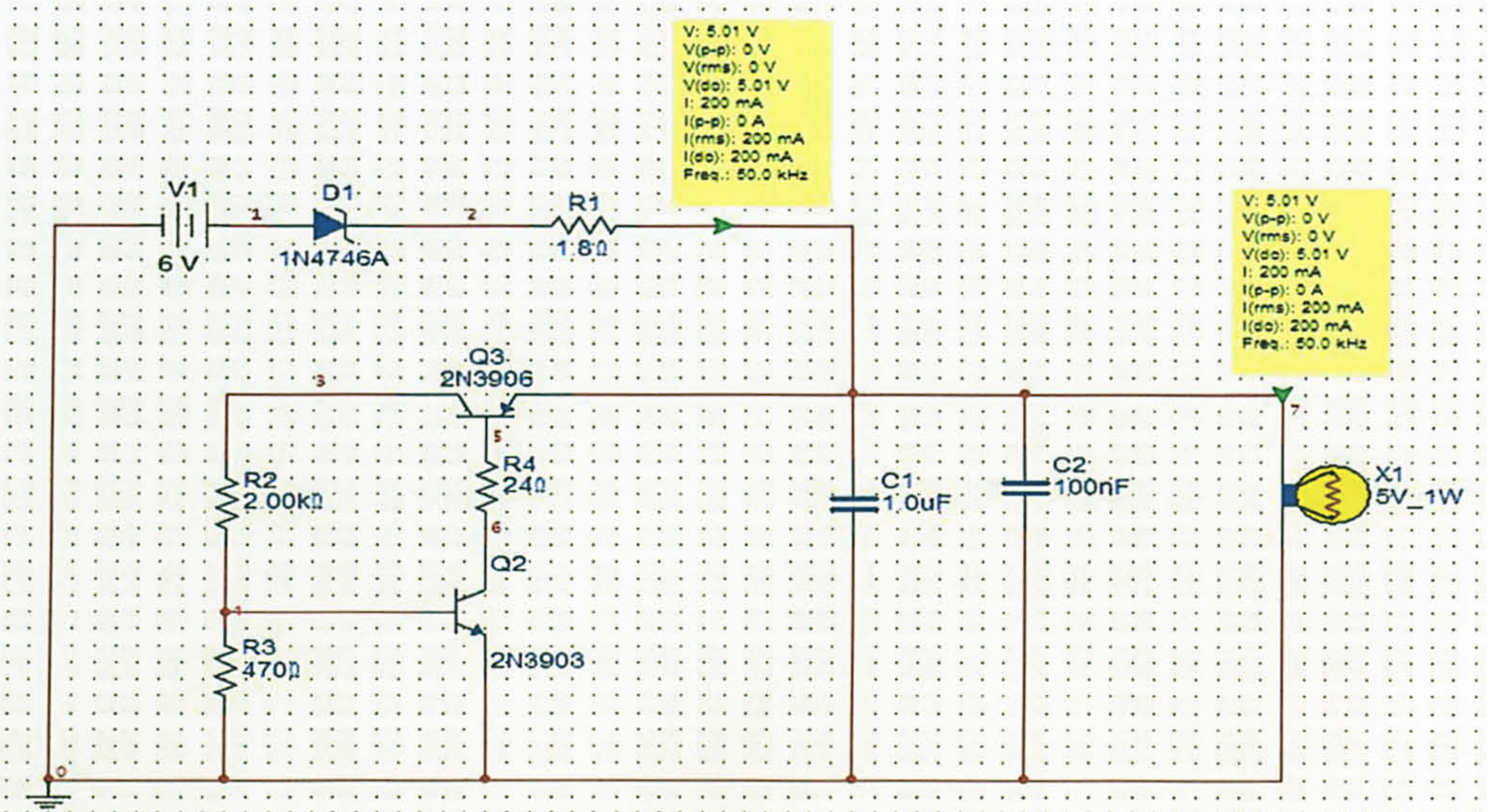


Figure 15:

Operation of the circuit during V_2 breakdown

During V_1 Breakdown :

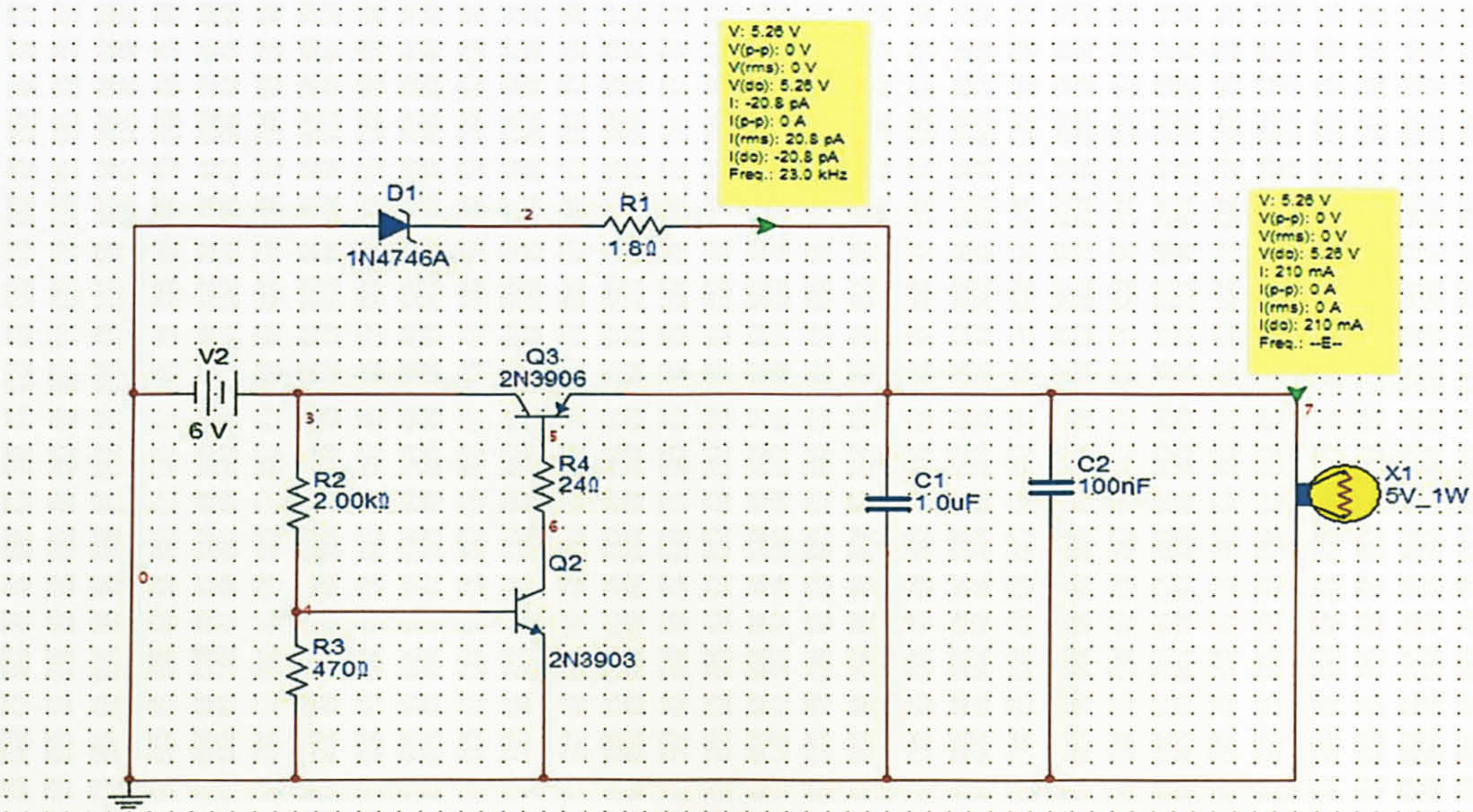


Figure 16: Operation of the circuit during V_1 breakdown

4.2.2 Converter circuit

The converter circuit consists of rectifier circuit, filter capacitor circuit and regulator circuit. The combination of the three circuit will convert AC voltage to DC voltage then it will be filtered through the capacitor filter to reduce most of the dc component while attenuating as much AC component possible. Then the voltage regulator circuit will maintain a constant DC output voltage for the system.Figure 17 shows the converter circuit simulation:

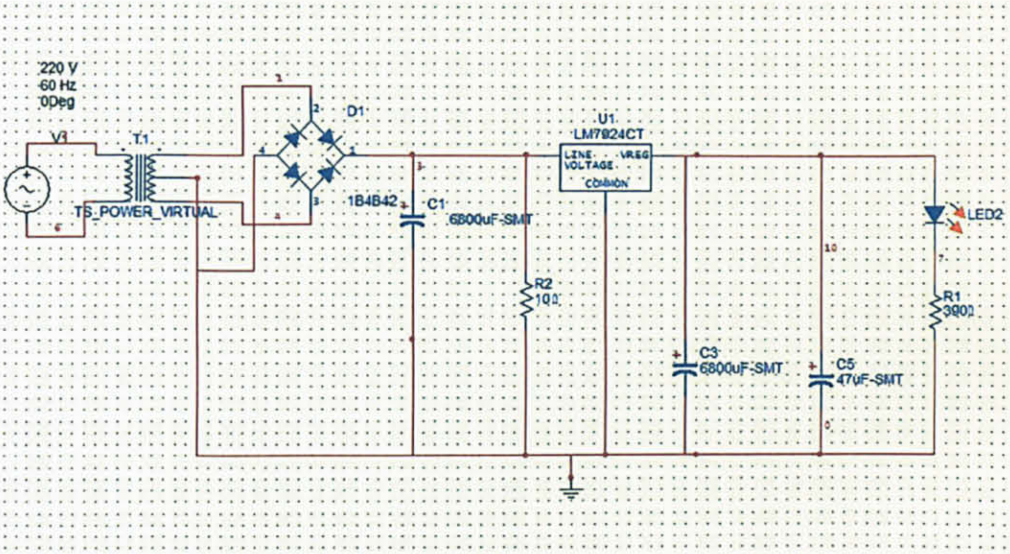


Figure 17: Converter Circuit Simulation

The output from the rectification circuit is connected as the input for regulator circuit. A voltage regulator is designed to maintain a constant voltage level. LM7806 voltage regulator is utilized in this circuit to maintain a 6VDC output voltage.

Figure 18 shows the diagram of the converter circuit during the operation:

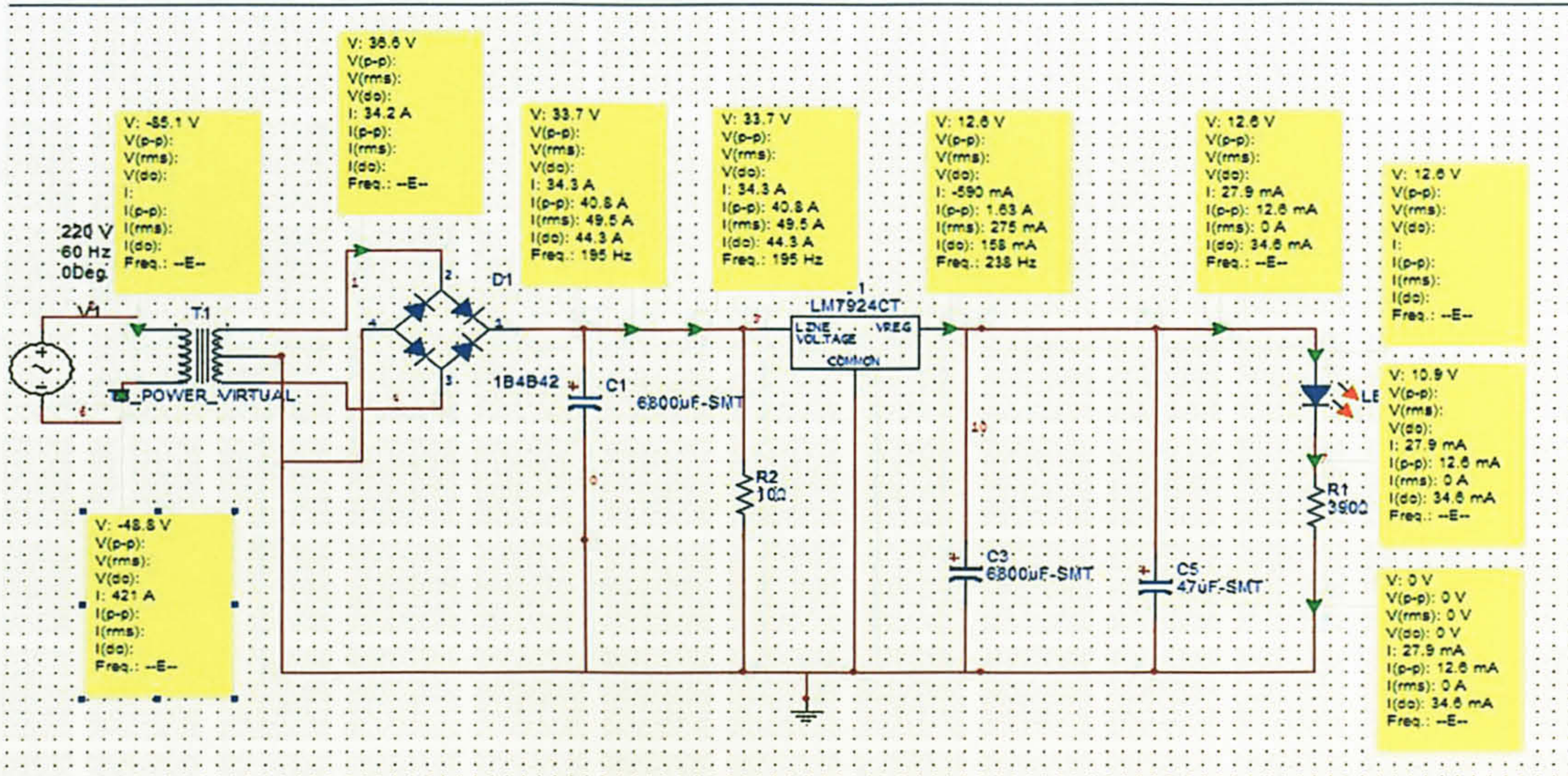


Figure 18: Operation of the converter circuit

4.2.3 Battery charging circuit

Battery charger circuit in this project is used to store energy into the rechargeable battery at certain current that will allow energy to be installed. The chosen rechargeable battery is a 6V sealed rechargeable battery. In this case the turbine must be able to generate 1.2A and the voltage of 6.6 V – 6.8 V to charge the battery. This circuit has a current limiter which is built in to prevent the output current from exceeding the rated current and prevent overheated condition during under load. Apart from that, the variable resistor in the circuit is used to control the resistance in the circuit so the current will maintain at 1.2A and above thus it will allow the circuit to charge the battery. Figure 19 shows the battery charger circuit:

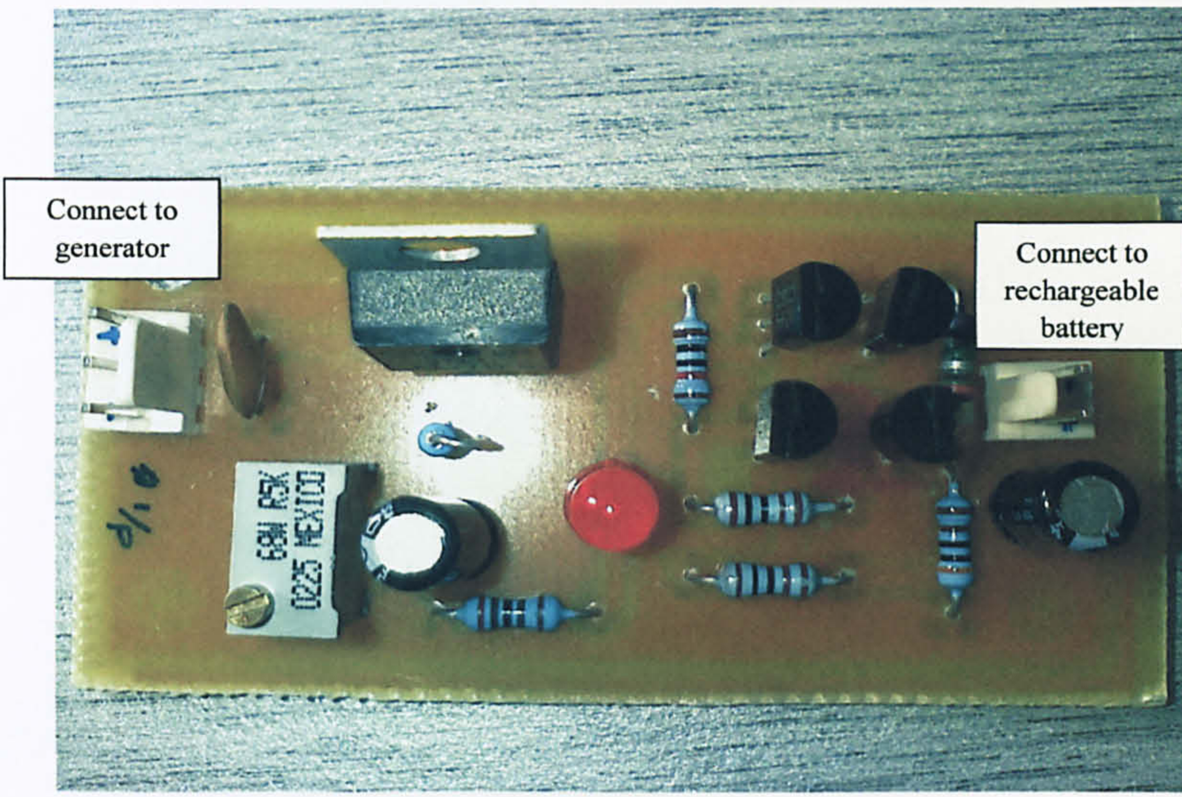


Figure 19: Battery Charger circuit

Figure 20 shows the operation of the battery charger circuit:

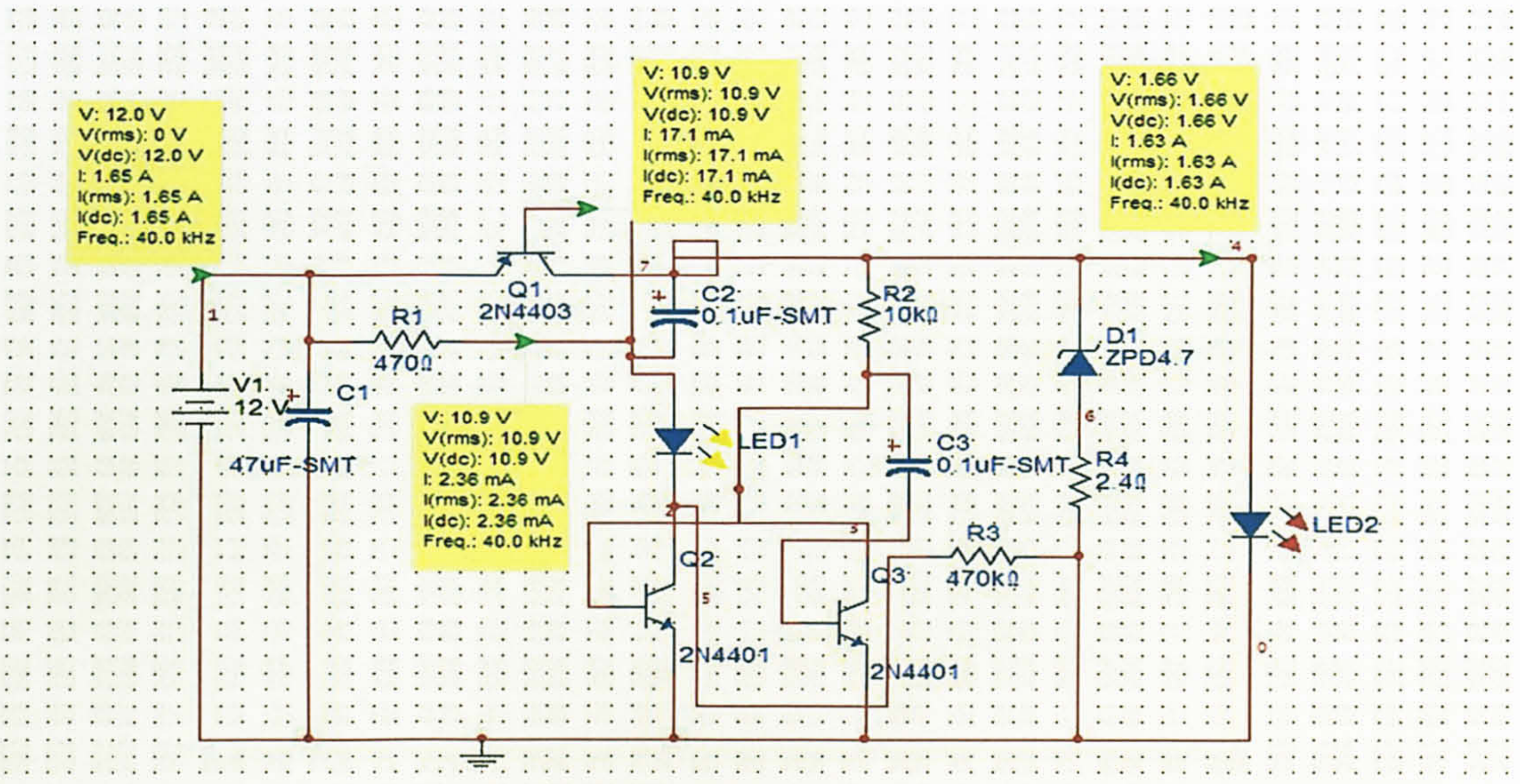


Figure 20: Battery Charger

4.3 Prototype Circuit

Figure 21 shows the model prototype of the circuit which consists of converter circuit, switching circuit and battery charger circuit:

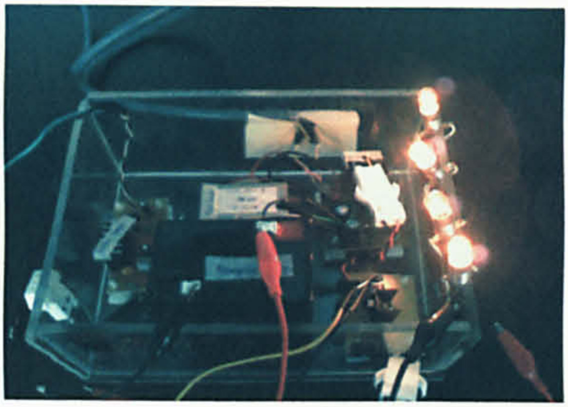


Figure 21: Circuit in Testing

4.4 Prototype Construction

4.4.1 Engineering Analysis

Types of turbines of the prototype are properly chosen according to the turbine application chart (refer Figure 6). The turbine blades of the prototype are in curve shape. This shape is made in order to decrease the friction of the water flow and at the same time more water can flow through the turbine. This will increase the torque to rotate the turbine shaft thus produce more energy. The blades of the turbines are shown in Figure 22:

Figure 22: Turbine blades

The turbine is connected to the generator through connector shaft which is made from aluminum rod. A hole is been drill at the connector where it could be join both the turbine and generator shaft together. Figure 21 shows the connecting shaft between turbine and generator:

Figure 23: Shaft

The completed design of the small scale micro hydro generation system is shown in Figure 24:

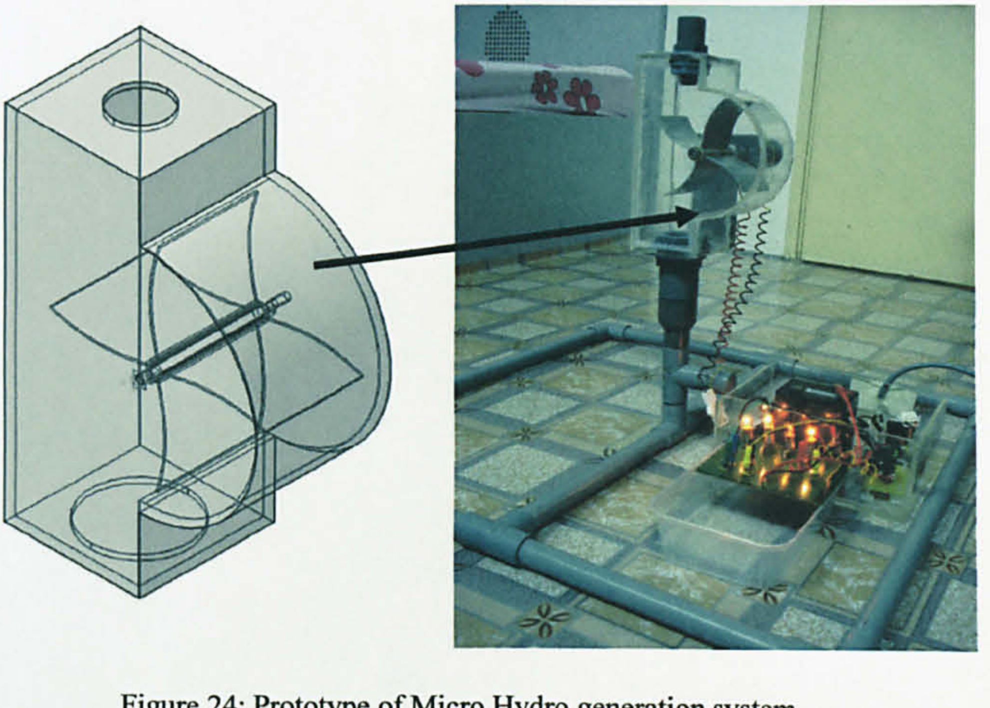


Figure 24: Prototype of Micro Hydro generation system

4.4.2 Experimental Result

Small scale that represents the real micro hydro system by the ration 1:100 is built and tested. The flow rate of the water flowing through domestic pipe is determined in order to estimate the input power. Flow rate of the water is determined as in Figure 25:

The Volume of a pail is determined

↓

A stopwatch has been prepared for the time determination

↓

As the pipe is opened, "START" button on the stopwatch was pressed

↓

The "STOP" button was press as the pail was full

↓

The time taken for the water to filled up the pail was recorded

↓

Determine flow rate by dividing volume over period taken

Figure 25: Flow rate test

Thus the input power can be calculated. The flow rate obtained is $4.49m^3/s$.
Input power is calculated according to the formula below:

P th = (Q) (H) (g)

where,

Q = Usage flow rate (m3 /s)
H = Gross Head in meters
g = gravitational constant (9.8m/s)

Therefore, the ***input power*** is:

$$P\ th = (0.0104\ m3\ /s)\ (4.49\ m)(9.8 m/s)$$
$$= 0.458\ W$$

where,

$Q = 0.0104\ m3\ /s$
$H = 4.49\ m$
$g = 9.8 m/s$

The ***experimental output power*** obtained through installing the micro hydro system at the domestic pipelines for a period. The voltage produced and current produced is obtained through this experiment.

Therefore, the ***experimental output power*** is:

$$P = I\ V$$
$$= 46.8\ m\ A\ (7.05\ V)$$
$$= 0.329\ W$$

where ,

$I = 46.8 mA$

$V = 7.05\ V$

Thus the efficiency of the system is :

$$Efficiency\ (\%) = \frac{Output\ power}{Input\ power} X\ 100\%$$

$$= \frac{0.329W}{0.458\ W} X\ 100\%$$

$$= \mathbf{71.8\ \%}$$

4.5 Discussuion

Switching circuit is supported by two types of power supply which both is 6v supply which is generated and another is from the converted supply from main supply (240v supply) from the micro hydro turbine. If there is a power breakdown occurs at the generated hydro energy, the switching circuit will act as a switch to switch from the generated hydro energy to the main supply and vice versa.

The switching circuit mechanism is based on the application of transistor. When both power supply (generated supply and converted 240 supply) is used, the output of the circuit is 5.35 V. In the process of simulation, one of the supply which is the converted 240 supply is under breakdown condition, the output voltage is 5.26 v while when the generated supply is under breakdown condition,the output voltage is observed as 5.01V.Here ,it is observed that whenever there is any breakdown in one of the power supply, the electrical appliance that connected to this micro hydro system will be still functioning under breakdown .

Converter circuit consists of combination of transformer, rectifier circuit, and filter circuit whereby the AC voltage which is fed to the circuit is converted to DC voltage through the rectifier circuit. On the other hand, filter circuit is used to reduce ripple of the signal. To eliminate ripple action in the signal, the RC charging time of the filter capacitor must be short while RC discharge time must be long. In short, the capacitor must charge up as fast as possible and no discharge during the charging session.

Battery charging circuit used in this project has built in current limiter which is to prevent output current from exceeding the rated current and it will automatically reduce its output current if an overheat condition occurs under load. It is also consists of variable resistor in the circuit is used to vary the resistance in the circuit so the current produce is at desired current. A low current is needed in order to operate the charger circuit thus variable resistor will be used in this situation. Main part of the circuit is LM 317 which is known as the "three terminal adjustable regulator".LM 317 can support input voltage from the range 3V-40V and the output voltage from range 1.25V-37V and with the current rating of 1.5A.

When the converter circuit (which consists of rectifier, capacitor filter and voltage regulator circuit), switching circuit and battery charger circuit is all working, the output of this circuit is able to operate the load (light bulb) as shown in Figure 24

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the research conducted, two data input parameter which is very important to ensure the developments of the system are water pressure and the water supply flow rate. Feasibility study of UTP water supply has been conducted and the data obtained shows that the project is feasible for further research in developing the large scale of the micro hydro generation system. The simulation circuit of the converter circuit, witching circuit and battery charger circuit also had work properly as estimated. The small scale model of ratio 1: 100 has been built which consists of the turbine, generator and the working circuit. Testing has been conducted and the system is working as expected and able to produce electricity to support the load which is the light bulb in this case.

5.2 Recommendations

Redefine the design by increasing the head and modification on the turbine of the system can be done to improve the system so it will be able produce higher output power. Additionally, further research should be done to improve the system so it can also be located or install to the consumer waste water pipeline.

However, few considerations should be taken such as water flow should clear from any blocking agent such as body waste and alternate pipeline should be installed to avoid blockage or unwanted overflow. Besides, an investigation on the charging period of the battery should be done in the future project.

REFERENCES

[1] Renewable Energy-Eco Friendly

http://www.docstoc.com/docs/10400483/Renewable *Energy*

[2] Keith J.Sparks;2002;Advantages of Hydroelectric Energy as Alternative Energy Source

[3] Dan New;Jan 2005;Intro to Hydropower ;Texas; *HP103_pg14_New*

[4] H. Zainuddin, M. S. Yahaya, J. M. Lazi, M. F. M. Basar and Z. Ibrahim, "Design and Development of Pico-hydro Generation System For Energy Storage Using Consuming Water Distributed to Houses"

[5] Dan New;Jan 2005;Intro to Hydropower ;Texas; *HP103_pg14_New*

[6] http://en.wikipedia.org/wiki/Volumetric_flow_rate

[7] Roger A.Hinrichs,1996,Energy :Its Use and the environment,2nd Edition;Saunders College Publishing,Orlando

[8] http://www.homepower.com/article/?file=HP104_pg42_New

[9] CanadaMicroHydroGuide ;Society of Canada Inc.*MicroHydropower Systems* , 2004

[10] A. Harvey, A. Brown, P. Hettiarachi and A. Inversin, 'Micro hydro design manual: A guide to small-scale water power schemes,' Intermediate Technology Publications, 1993.

[11] J. Mariyappan, S. Taylor, J. Church and J. Green, "A guide to CDM and family hydro power," Final technical report for project entitled Clean Development Mechanism (CDM) project to stimulate the market for family-hydro for low income families, IT Power, April 2004

[12] N. Smith and G. Ranjitkhar, "Nepal Case Study–Part One: Installation and performance of the Pico Power Pack," *Pico Hydro Newsletter*, April 2000.

[13] Thematic Network on Small hydropower(TNSHP) of Layman's Guidebook;Guide on how to develop a small hydropower plant;1998

[14] Paul Cunningham and Barbara Atkinson;2007;Micro Hydro Power Systems;Sweeden

[15] "From Water to wire: Building a Micro hydro system by Peter Talbot ,HP76

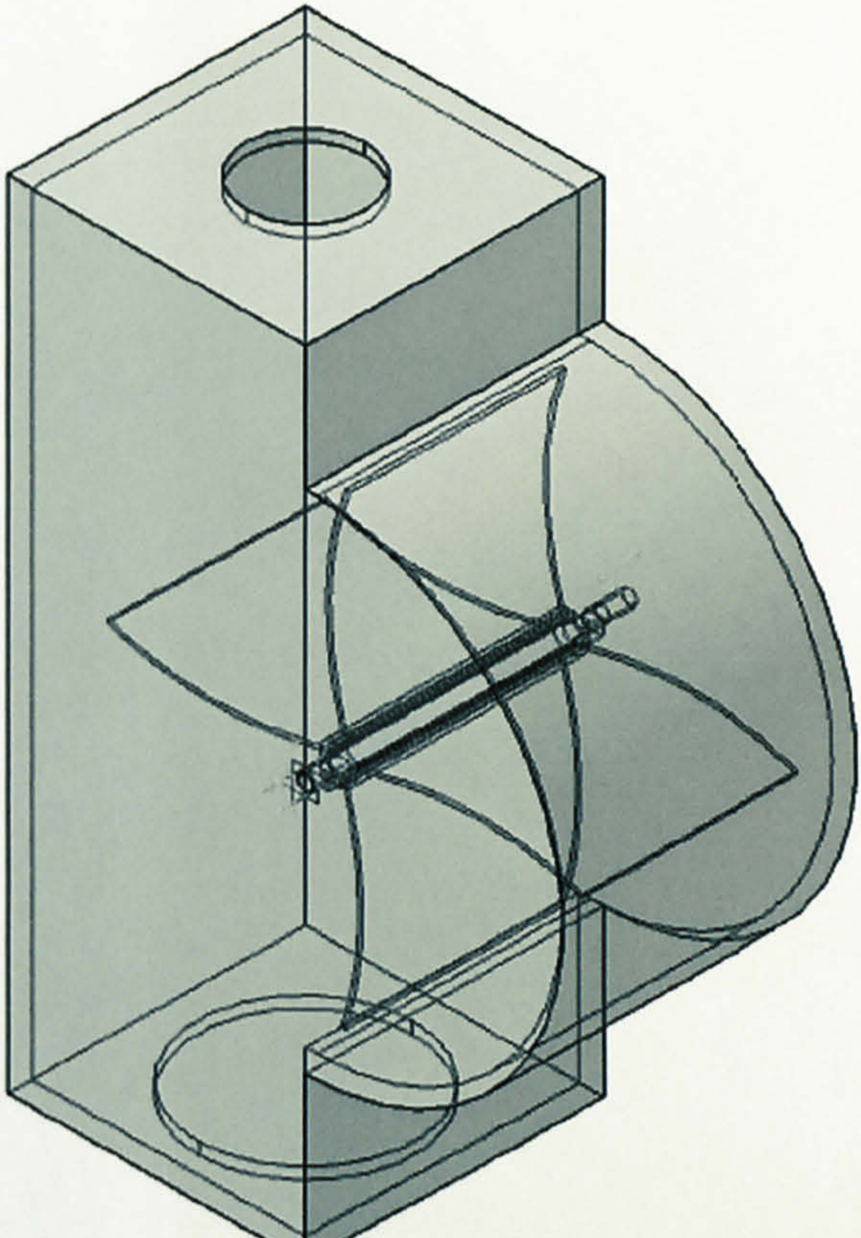
[16] http://www.hydromaxenergy.com/Green Power RunofRiverHydroPower/Run -of-River+Hydro+Power.htm

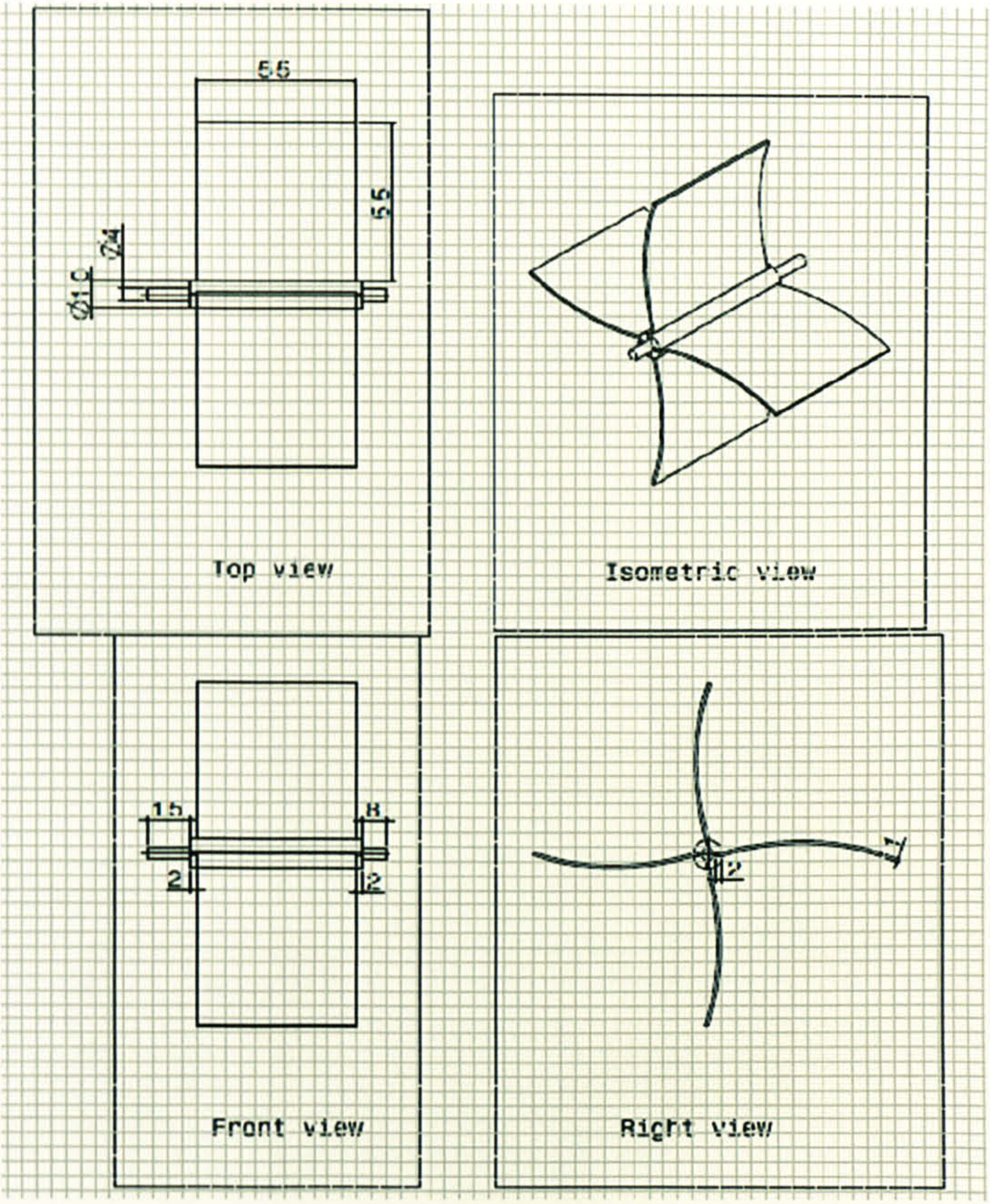
[17] P. Maher and N. Smith, "Pico hydro for village power: A practical manual for schemes up to 5 kW in hilly areas," 2nd ed., Intermediate Technology Publications, May 2001.

[18] Analgor Integrated Circuits and Signal Processing,Vol 6,Spring Netherlands

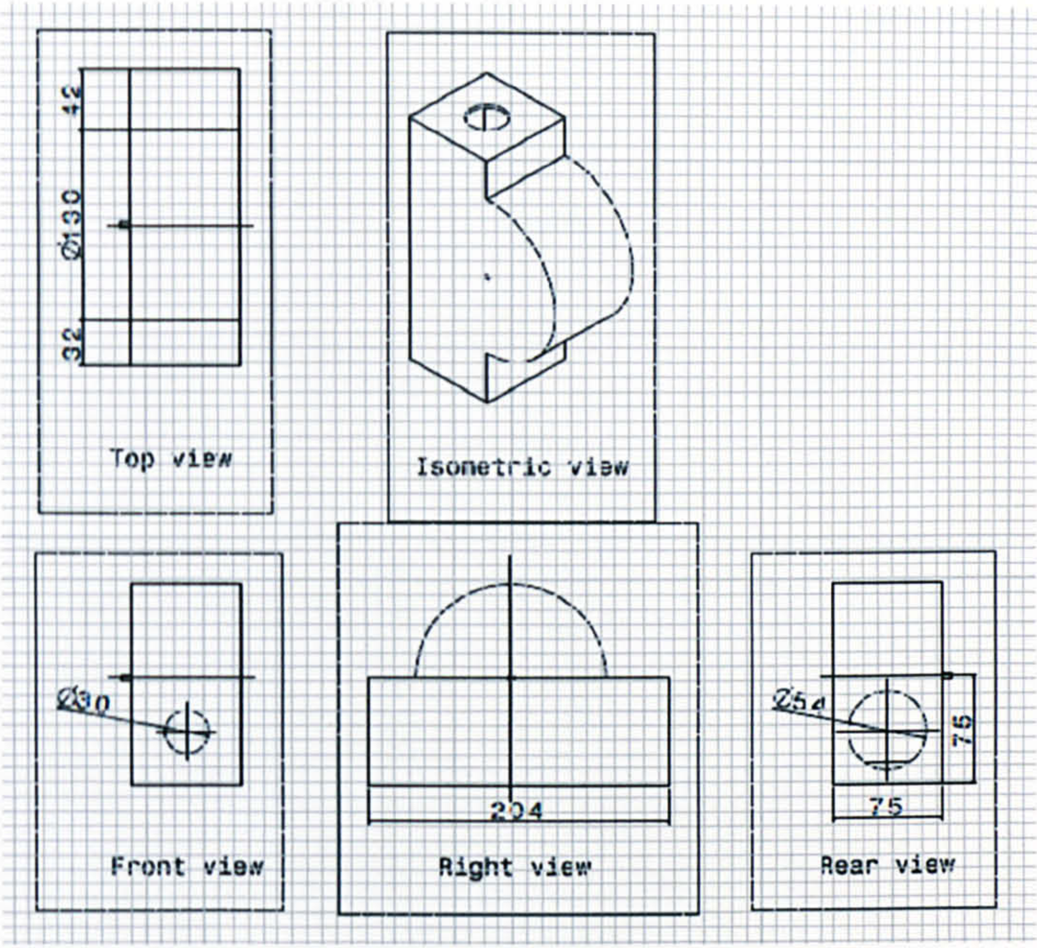
APPENDICES

APPENDIX A
ENGINEERING DRAWING





55
55
Ø4
Ø10
Top view
Isometric view
15
8
2
2
Front view
2
1
Right view

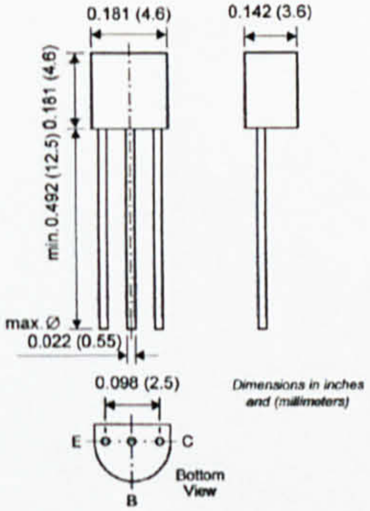

42
Ø130
32
Top view
Isometric view
Ø30
Front view
204
Right view
Ø54
75
75
Rear view

APPENDIX B

DATA SPECIFICATION

Small Signal Transistor (PNP)

TO-226AA (TO-92)



Features

- PNP Silicon Epitaxial Planar Transistor for switching and amplifier applications.
- As complementary type, the NPN transistor 2N4401 is recommended.
- On special request, this transistor is also manufactured in the pin configuration TO-18.
- This transistor is also available in the SOT-23 case with the type designation MMBT4403.

Mechanical Data

Case: TO-92 Plastic Package
Weight: approx. 0.18g
Packaging Codes/Options:
E6/Bulk – 5K per container, 20K/box
E7/4K per Ammo mag., 20K/box

Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

Parameter		Symbol	Value	Unit
Collector-Emitter Voltage		$-V_{CEO}$	40	V
Collector-Base Voltage		$-V_{CBO}$	40	V
Emitter-Base Voltage		$-V_{EBO}$	5.0	V
Collector Current		$-I_C$	600	mA
Power Dissipation	T_A = 25°C Derate above 25°C	P_{tot}	625 5.0	mW mW/°C
Power Dissipation	T_C = 25°C Derate above 25°C	P_{tot}	1.5 12	W mW/°C
Thermal Resistance Junction to Ambient Air		$R_{\theta JA}$	200	°C/W
Thermal Resistance Junction to Case		$R_{\theta JC}$	83.3	°C/W
Junction Temperature		T_j	150	°C
Storage Temperature Range		T_S	–55 to +150	°C

Electrical Characteristics (T_J = 25°C unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
DC Current Gain	h_{FE}	$-V_{CE}$ = 1 V, $-I_C$ = 0.1 mA $-V_{CE}$ = 1 V, $-I_C$ = 1 mA $-V_{CE}$ = 1 V, $-I_C$ = 10 mA $-V_{CE}$ = 2 V, $-I_C$ = 150 mA $-V_{CE}$ = 2 V, $-I_C$ = 500 mA	30 60 100 100 20	— — — — —	— — — 300 —	—
Collector Cutoff Current	$-I_{CEV}$	$-V_{EB}$ = 0.4 V, $-V_{CE}$ = 35 V	—	—	100	nA
Base Cutoff Current	$-I_{BEV}$	$-V_{EB}$ = 0.4 V, $-V_{CE}$ = 35 V	—	—	100	nA
Collector-Emitter Saturation Voltage[1]	$-V_{CEsat}$	$-I_C$ = 150 mA, $-I_B$ = 15 mA $-I_C$ = 500 mA, $-I_B$ = 50 mA	— —	— —	0.40 0.75	V
Base-Emitter Saturation Voltage[1]	$-V_{BEsat}$	$-I_C$ = 150 mA, $-I_B$ = 15 mA $-I_C$ = 500 mA, $-I_B$ = 50 mA	0.75 —	— —	0.95 1.30	V
Collector-Emitter Breakdown Voltage	$-V_{(BR)CEO}$	$-I_C$ = 1 mA, I_B = 0	40	—	—	V
Collector-Base Breakdown Voltage	$-V_{(BR)CBO}$	$-I_C$ = 0.1 mA, I_E = 0	40	—	—	V
Emitter-Base Breakdown Voltage	$-V_{(BR)EBO}$	$-I_E$ = 0.1 mA, I_C = 0	5.0	—	—	V
Input Impedance	h_{ie}	$-V_{CE}$ = 10 V, $-I_C$ = 1 mA, f = 1 kHz	1.5	—	15	kΩ
Voltage Feedback Ratio	h_{re}	$-V_{CE}$ = 10 V, $-I_C$ = 1 mA, f = 1 kHz	$0.1 \cdot 10^{-4}$	—	$8 \cdot 10^{-4}$	—
Current Gain-Bandwidth Product	f_T	$-V_{CE}$ = 10 V, $-I_C$ = 20 mA f = 100 MHz	200	—	—	MHz
Collector-Base Capacitance	C_{CB}	$-V_{CB}$ = 10 V, I_E = 0, f = 1.0 MHz	—	—	8.5	pF
Emitter-Base Capacitance	C_{EB}	$-V_{EB}$ = 0.5 V, I_C = 0 f = 1.0 MHz	—	—	30	pF
Small Signal Current Gain	h_{fe}	$-V_{CE}$ = 10 V, $-I_C$ = 1 mA f = 1 kHz	60	—	500	—
Output Admittance	h_{oe}	$-V_{CE}$ = 10 V, $-I_C$ = 1 mA f = 1 kHz	1.0	—	100	µS

Notes:
(1) Pulse test: Pulse width ≤ 300µs - Duty cycle ≤ 2%

Electrical Characteristics (TJ = 25°C unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Delay Time (see fig. 1)	t_d	$-I_{B1}$ = 15 mA, $-I_C$ = 150 mA, $-V_{CC}$ = 30 V, $-V_{EB}$ = 2 V	—	—	15	ns
Rise Time (see fig. 1)	t_r	$-I_{B1}$ = 15 mA, $-I_C$ = 150 mA, $-V_{CC}$ = 30 V, $-V_{EB}$ = 2 V	—	—	20	ns
Storage Time (see fig. 2)	t_s	$-I_{B1}$ = $-I_{B2}$ = 15 mA, $-I_C$ = 150 mA, $-V_{CC}$ = 30 V	—	—	225	ns
Fall Time (see fig. 2)	t_f	$-I_{B1}$ = $-I_{B2}$ = 15 mA, $-I_C$ = 150 mA, $-V_{CC}$ = 30 V	—	—	30	ns

Switching Time Equivalent Test Circuit

Figure 1 - Turn-On Time

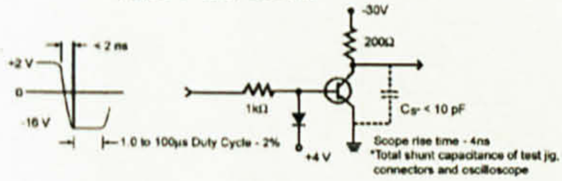
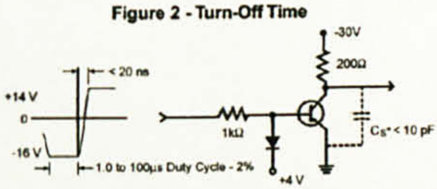
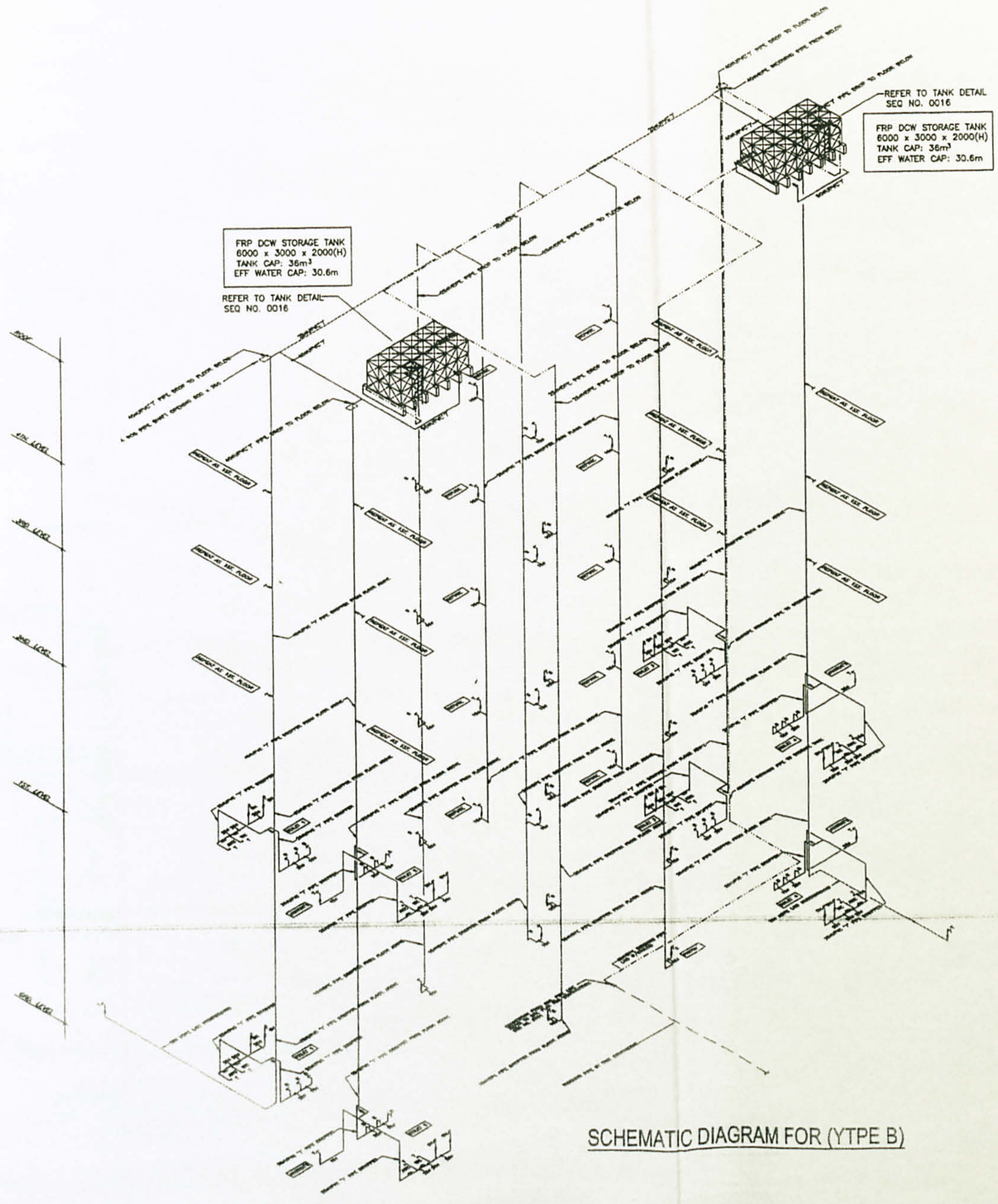


Figure 2 - Turn-Off Time





SCHEMATIC DIAGRAM FOR (YTPE B)

NOTE:
ALL PIPE ON WALL SHALL NOT RUN EXPOSED

AS BUILT DRAWING

UNIVERSITI TEKNOLOGI PETRONAS

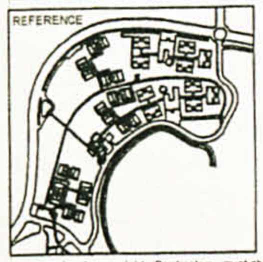
CADANGAN PEMBANGUNAN FASA
UNIVERSITI TEKNOLOGI PETRONAS
DIATAS LOT-LOT 13157 MUKIM BOTA
DAN TANAH KERAJAAN PLOT 1
MUKIM BOTA SERTA PLOT 2
MUKIM LAYANG - LAYANG
DAERAH PERAK TENGAH
DI BANDAR SRI ISKANDAR
PERAK DARUL RIDZUAN

SUBTITLE

CADANGAN MEMBINA & MENYIAPKAN
HOSTEL PELAJAR (PAKEJ 4) FASA 2 UNIVERSITI TEKNOLOGI
PETRONAS YANG MENGANDUNGI :-
10 BLOK PANGSAPURI 5 TINGKAT
1 BLOK PUSAT PERKAMPUNGAN 2 TINGKAT
UNTUK
TETUAN INSTITUTE OF TECHNOLOGY PETRONAS SDN BHD

Rev	Date	Particular
00	12/07/04	1) AS-BUILT FOR APPROVAL

REFERENCE



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LANDSCAPE ARCHITECT

GILLESPIES

QUANTITY SURVEYOR

KPK

MAIN CONTRACTOR

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JALAN AMPANG, KUALA LUMPUR
MALAYSIA
TEL : (603) - 2161 6344 FAX : (603) - 2161 6373

DRAWING TITLE

COLD WATER PLUMBING SERVICES

SCHEMATIC DIAGRAM - HOSTEL BLOCK TYPE B

DRAWING NO:

PROJECT					CONTRACTOR
PROJECT	PHASE	BROADBASE	PACKAGE	SUB-PACKAGE	CONTR
UTP	A2a	04B	ASA	CASA	STTMJV
DATE	PARCEL NO	TYPE	TRADE	SEQUENCE NO	REV
7/04	41300	AB	15400	0012	00
SCALE N.T.S	SCALE BAR				
DRAWN BY YBM	CHECKED BY LAI	CAD REF#			